INSTRUCTION IN SCIENCE AND ART FOR WOMEN.

NOTES

OF TWELVE LECTURES

ON

"PHYSIOGRAPHY,"

DELIVERED BY

PROFESSOR HUXLEY, F.R.S.

IN THE

LECTURE THEATRE

OF THE

SOUTH KENSINGTON MUSEUM

DURING

NOVEMBER AND DECEMBER 1870.

INSTRUCTION IN SCIENCE & ART FOR WOMEN.

SYLLABUS OF THE 2ND LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Saturday 12th November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The right bank of a river is that which lies on the right hand when the back is turned to the source of the river.

2. When the face is turned towards the North, the East lies to the right hand, the West on the left hand, the South behind. The position of the Sun, at mid-day, indicates the South; that of the Pole Star, the North. The magnetic needle approximately indicates the North and the South.

3. By general consent the top of an ordinary map is assumed to be the North. The size of a map bears a certain proportion to that of the countries it represents. This proportion is the scale of the map.

4. The course of the Thames and of its affluents is determined by the shape of the ground which forms the surface of the Thames basin. The Thames basin is bounded by relatively high lands, which separate it from other river basins and are called "water-partings." Portions of these high lands rise into hills, such as the Chiltern hills on the North; the Cotswolds, on the West; the North Downs, on the South.

5. The whole surface of Great Britain is divided by water-partings into a series of river basins; and these are separated into three groups by a three-rayed water-parting, which has nothing to do with the highest hills or mountains.

6. A vertical section of the ground which forms the middle of the basin of the Thames shews it to be composed of layers of gravel, sand, and clay several hundred feet thick; and beneath this of chalk, which, in many places, contains flints. Towards the edge of the basin, on all sides, the layers of gravel, sand, and clay disappear, and the chalk lies at the surface.

7. Gravel and sand are easily permeated by water; clay is not; chalk, when solid, is not. These circumstances, and the arrangements of the beds, determine the existence of springs and wells.

8. The gravel and sand are such as may be found in the bed of a rapid stream, or at the foot of a cliff on the sea shore.

9. The clay is mud, such as may be found at the bottoms of slow moving rivers or sheltered places in the sea, dried and hardened.

10. The chalk is mud, such as exists at the bottom of the Atlantic ocean, dried and hardened.

INSTRUCTION IN SCIENCE & ART FOR WOMEN.

SYLLABUS OF THE 3RD LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Wednesday 16th November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The Thames and its basin have not existed for ever as they now exist.—Every year the rain-fall washes, or dissolves away, part of the soil over which it flows and carries it to the sea.—This is *Pluvial Denundation.*

2. The present form of the basin determines the course of the river; but the rain has given rise to the present form of the basin.

3. The action of the rain again is determined by the nature and the arrangement of the beds of which the ground forming the river basin is composed.

4. Rain and river dissolve away chalk; rub down flint into gravel and sand; and wash clay into mud.

5. The Thames carries down to the sea not less than 14,000,000 cubic feet of solid material, either dissolved or as mud, every year.—At the present rate of denundation the whole basin would be washed down to the sea level in 1,000,000 years; and the surface of Britain would everywhere be washed down to a plain, level with the sea, in less than 5,000,000 years.

6. The undissolved matter carried down by river is deposited in the form of layers of mud, sand, and gravel in its estuary or delta.—In any given place the undermost of these layers must needs be oldest.

INSTRUCTION IN SCIENCE & ART FOR WOMEN.

SYLLABUS OF THE 4TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Saturday 19th November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. Every thousand pounds of Brighton sea water contains about twenty seven pounds of common salt and eight pounds of other solid matters, making thirty-five pounds in all. If a certain measure of pure fresh water weighs a thousand pounds, the same quantity of Brighton sea water weighs a thousand and twenty-seven pounds. A thousand pounds of the water of the Thames at Twickenham contains only a little more than five ounces of solid matter, the greater part of which is carbonate of lime. If a certain measure of pure fresh water weighs a thousand pounds, the same quantity of Thames water weighs a thousand pounds and five ounces.

2. The sea is set in motion by tides, currents, and winds. When in motion it tends to wear down the land, and gives rise to *marine denudation*.

3. Cliffs and beaches, shingle and sand, are the results of marine denudation accompanied or not by pluvial denudation.

4. The motion of the largest waves is almost imperceptible at a depth of three hundred fathoms (a fathom=6 feet). The denuding action of ordinary waves must be insignificant at a third of this depth. The sea therefore acts upon the land as a sort of rotating chisel and tends to cut it down to the depth of 100 fathoms below the surface.

5. Other things being alike, the indentations and headlands of a coast depend upon the nature and arrangement of the strata of which it is composed.

6. Supposing rain and rivers to have reduced all the land of Britain to the sea level, marine denudation would gradually plane down what was left until, in place of the land, there was sea 100 fathoms deep.

7. The materials thus worn down into fine sand would be carried away by tides and currents into deeper parts of the sea.

8. Snow and ice accumulating in elevated regions give rise to glaciers, or ice rivers, and there effect *glacial denudation*, and transport solid materials for indefinite distances over land and sea.

Books recommended for further study:

Prestwich.—"The Ground beneath us."
Ramsay.—"Physical Geology and Geography of Great Britain."
Geikie.—"Scenery of Scotland."
Tyndall.—"Glaciers of the Alps."

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SYLLABUS OF THE 5TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Wednesday 23rd November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. All denudation whether pluvial, marine, or glacial, tends to transport the dry land into the depths of the sea and there deposit it in horizontal beds, or strata. Therefore, given time, denudation must finally reduce all the land to a submarine plain which will exist for ever, if there be no reparative natural agency competent to produce new dry land.

2. Two such reparative agents exist in nature; the one is *Plutonic*, the other *Vital*. The Plutonic agent is the hot inner substance of the earth; the Vital agent is protoplasm.

3. The interior of the earth is hotter than the surface, the increase of temperature taking place at the rate of about 1 degree Fahrenheit for every 50 feet of vertical descent. If the temperature increases regularly at this rate, the heat at a depth of 20 miles must be great enough to melt all substances with which we are acquainted.

4. As a matter of fact, melted rock is being constantly thrown out in many parts of the world, and in enormous quantities from certain vents, or holes, in the crust of the earth which are called Volcanos.

5. The matters thrown out are steam; volcanic ashes, and stones; mud; and streams of melted rock called lava. The heap of these matters which accumulates round the vent is a volcanic mountain.

6. The same Plutonic agent which gives rise to volcanos also effects movements of the crust of the earth, which may raise strata formed by denudation above the sea level and convert them into new dry land. On the other hand it may depress existing strata; and, bringing them within range of the melting point, give rise to a sort of *igneous denudation*.

7. From these considerations it follows that the solid matter of the globe is undergoing the same eternal circulation as the water of the Thames. The immediate agent of that circulation is in all cases water in its three forms of *ice*, *water* (commonly so called), and *steam*; the remote agent is heat, firstly, of the Sun, and, secondly, of the interior of the Earth.

Books recommended for further study:

Scrope.—"Volcanos." 2nd Ed. Longmans, 1852.
Phillips.—"Vesuvius." Van Voorst, 1869.

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SYLLABUS OF THE 6TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Saturday 26th November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. Protoplasm is found in plants and animals. These convert fluid and gaseous matters into dense solids which, under favourable circumstances, accumulate in strata of vast thickness.

2. Peat-bogs are examples of the accumulation of solid matter upon the earth's surface by the action of plants.

3. Many thousand square miles of the bottom of the Atlantic Ocean, 10,000 to 15,000 feet beneath the surface of the sea, are at present being covered with a chalky and silicious substance by the action of plants and animals (*Diatomaceæ*, *Bathybius*, *Foraminifera*, *Radiolaria*, *Spongidæ*).

4. Great areas of the bottom of the Pacific and other oceans are at present being covered by beds of limestone, which are the products of certain animals (*Actinozoa*).

5. A considerable portion of that part of North America, which is now called Florida, has been made by animals *Actinozoa* and is now being extended by the same means.

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SYLLABUS OF THE 7TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Wednesday 30th November 1870, at 11 a.m.

PHYSIOGRAPHY.

1. Protoplasm is a complex body consisting almost entirely of carbon, hydrogen, oxygen, and nitrogen.

2. Ordinary plants consist of masses of protoplasm, each provided with a wooden case, associated together. The plant feeds, grows, multiplies, dies, and is resolved into simple compounds, which are chiefly carbonic acid, water, and ammonia.

3. Ordinary animals consist of masses of protoplasm not inclosed in wooden cases, but imbedded in other matters which result from the modifications of protoplasm. The animal feeds, grows, multiplies, dies, and is resolved into simpler compounds which are, chiefly, carbonic acid, water, and ammonia.

4. Ordinary animals cannot make protoplasm, but must be supplied with it: ordinary plants can make it from carbonic acid, water, and ammonia.

5. The matter contained in living bodies is continually undergoing a circulation from the not-living world, through the living world, back to the not-living world.

SYLLABUS OF THE 8TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Saturday 3rd December 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The ultimate conditions of the circulation of the watery and solid matters of the earth whether living or not living, are heat and light. The great source of these, outside the earth, is the sun.

2. The sun is a globe, the surface of which consists of gaseous matters, by and through which it radiates its heat into space. Its diameter is more than a hundred times that of the earth, and its bulk more than a million times as great as that of the earth. The distance between the earth and the sun is about eleven thousand five hundred times the diameter of the earth; or a hundred and eleven times that of the sun. The sun turns round on its axis, the ends of which are its *poles*, once in twenty-five, or twenty-eight days, and its surface is measured by imaginary *meridians of longitude* and *parallels of longitude*.

3. The earth is also a globe (rather less than 8000 miles in diameter) the surface of which consists of gaseous matters, by and through which it radiates its heat into space. The earth turns round on its axis once in twenty-four hours. The terms poles, meridians, and parallels have the same meaning as in the case of the sun.

4. The surface of the earth which faces the sun, at any time, gains more heat than it loses and is illuminated. The opposite surface simply loses its heat and is dark.

5. If the earth and the sun had no motion relatively to one another, and if the earth were all solid and did not rotate upon its axis, the hemisphere which happened to be turned towards the sun would be intensely hot in the middle, cooler towards the circumference; while the opposite hemisphere would be intensely cold If there were no atmosphere, the contrast of climate would be less intense, and cold winds would blow, from all points of the compass, directly towards the middle of the hot hemisphere.

6. If the earth now began to rotate on its axis what would happen would depend upon the direction of the axis.—

   a. If the axis coincided with a prolonged radius of the sun, the only change would be in the direction of the winds.

   b. If the axis were perpendicular to a prolonged radius of the sun, all points of the surface at equal distances from the poles would be equally warmed and equally illuminated. The poles would be coldest; and the winds would be directed obliquely from the poles towards the equator.

   c. In any intermediate position, the parts of the surface at equal distances from the poles would be unequally warmed and illuminated; and one pole would be in everlasting darkness and cold.

As a matter of fact, the axis of the earth in in the position (*c*), but no part of the earth's surface is permanently dark and cold.

Books recommended for further study:

Lockyer.—"Lessons in Elementary Astronomy." Macmillan.

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SYLLABUS OF THE 9TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Wednesday 7th December 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The earth moves round the sun once in three hundred and sixty-five days and a quarter; and its path, or orbit, is almost circular. The positions of the earth's axis in all parts of its orbit, are parallel to one another; hence, the pole which is, at one time, directed towards the sun is, at another, turned from it.

2. The climate of any place on the earth's surface is determined, primarily, by the lengths of the days and nights and the relative duration of the seasons; and these again, depend upon the latitude of the place.

3. Secondarily, climate is determined (*a*) by the nature of the surface, whether water or land; and, if land, by the height of that land; (*b*) by currents of air; (*c*) by currents of water.

4. Land surfaces tend to have an extreme climate, water surfaces, a moderate climate. In all parts of the world, snow lies all the year round upon land elevated above a certain height. This height is the level of the *perpetual snow line.*

5. Currents in the air modify climate by transporting heat and watery vapour from one place to another. Over a large part of the surface of the earth the winds are nearly constant in their direction.

6. Currents in the sea transport heat from one place to another. They are caused partly by the unequal heating of the sea; partly by winds. Over a large part of the surface of the earth, the ocean currents are constant in their direction.

Book recommended for further study:

Tyndall.—Heat as a mode of motion, Lecture VI. Longmans.

INSTRUCTION IN SCIENCE & ART FOR WOMEN.

SYLLABUS OF THE 10TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum on Saturday the 10th December 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The climate of the basin of the Thames, and of Britain generally, is influenced by all the conditions which have been mentioned.

2. Animal and vegetable life can be maintained only within certain limits of temperature and moisture. Hence, the climate of Britain is one of the leading conditions of the existence of its living population.

3. The native animals of Britain are all found on the Eurasiatic continent. Some may have reached Britain by migration, but it is impossible that all should have done so, under the present geographical conditions.

4. The human inhabitants of Britain have the same physical and linguistic characters as the people of the adjacent parts of the Eurasiatic continent. It is possible that Britain was peopled with men by migration under the present geographical conditions.

5. At the earliest period recorded in history the anima population of Britain was the same as it is now, and the human population lacked only the Roman and Teutonic elements

SYLLABUS OF THE 11TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum, on Wednesday 14th December 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The gravel which lies at the surface of the Thames basin is, for the most part river gravel. It contains the remains of Elephants, Rhinoceroses, Oxen, Bisons, and Musk Sheep, with flints worked into implements by man.

2. At the time when this gravel was formed, the British Islands were united with the continent of Europe, and the Thames flowed into an estuary common to it and to the Rhine.

3. Some of the gravel of the northern half of the basin of the Thames is drift gravel. It consists of fragments of rocks from distant localities which have been brought into their present position by ice.

4. At the time the drift gravel was formed, Britain, north of the Thames, and all the northern regions of Eurasia and America, were covered by ice, or an icy sea.

5. The London Clay is the mud of the estuary of a great river. It contains the remains of Palms, of Crocodiles, Turtles, and of other animals now found only in hot climates.

6. The chalk is the mud of the bottom of a deep sea, which overspread the site of what is now a large part of Europe, Asia, and Africa. Neither the Pyrenees, nor the Alps, nor the Himalayas, were in existence when the chalk was formed.

7. The chalk was formed and upheaved into dry land before the river which gave rise to the London clay existed. The London clay was (at any rate in part) converted into dry land before the drift gravel existed. The river gravel is more recent than the drift gravel.

8. The climate of England during the deposition of the London clay (*Eocene period*) was much hotter than at present; during the formation of the drift and river gravels (*Glacial and Post-glacial periods*) it was much colder than at present.

9. The animals and plants of the chalk, were, for the most part, very different from those which now live in the British Islands, or the adjacent seas, or, indeed, which now exist anywhere. The likeness of the Eocene forms to existing animals and plants is far greater; while many of the Glacial and Post-glacial animals are identical with those which now exist in, or near, the British area.

INSTRUCTION IN SCIENCE & ART FOR WOMEN.

SYLLABUS OF THE 12TH LECTURE

ON THE

ELEMENTS OF PHYSICAL SCIENCE,

TO BE DELIVERED BY

PROFESSOR HUXLEY,

In the Lecture Theatre, South Kensington Museum on Saturday the 17th December 1870, at 11 a.m.

PHYSIOGRAPHY.

1. The gravel, the clay, and the chalk of the Thames basin record a vast period of time, during which the operations of denudation and reparation, and the general circulation of the matter of the world, went on as at present.

2. The series of deposits in the Thames basin is exceedingly incomplete. Superimposed upon the London clay, elsewhere, are the *nummulitic limestones* which were once formed at the bottom of a great ocean, nearly as extensive as that of the chalk.

3. Upon the nummulitic limestones again, the great series of deposits called *miocene* rest. They contain the remains of great numbers of terrestial animals and plants closely related to, but for the most part different from, those which now exist. During their formation, France was as full of volcanos as Iceland is at present.

4. Subsequent to these, in various parts of England and Europe, are great masses of *pliocene* deposits, containing remains of animals still more like those which exist at the present day.

5. The drift, represented by the beds of gravel in the Thames basin, consists, elsewhere, of great thicknesses of clay, sand, and gravel. It answers to a period of time, which has been called the *glacial* epoch.

6. The *post-glacial* period has been of very great duration.

7. The stratified deposits, from the chalk upwards, which are alone accessible in the Thames basin, constitute a mere fraction of the total series of such deposits; consequently, as there is no reason to believe that the processes of denudation and reparation were, on the average, more rapid when the oldest of these deposits were formed than they are now, the enormous period of time recorded by the floor of the Thames basin can be but a fraction of that recorded by the whole series of stratified rocks.

8. At the oldest periods of which any record exists, the earth had a solid crust, which was the product of aqueous denudation of some pre-existing solid crust; and, from that remote period to the present day, the matter of the earth has circulated from form to form, as it is now circulating in and around the basin of the Thames.